BEFORE THE STATE OF WASHINGTON

ENERGY FACILITY SITE EVAUATION COUNCIL

In the Matter of Application No. 2004-01: WIND RIDGE POWER PARTNERS, LLC; WILD HORSE WIND POWER PROJECT	EXHIBIT 36 (HKJ-T)

APPLICANT'S PREFILED DIRECT TESTIMONY
WITNESS # 17: HENRIK KANSTRUP JORGENSEN

Q Please state your name and business address.

A My name is Henrik Kanstrup Jorgensen and my business address is Smed Sørensen Vej 6, DK 6950 Ringkøbing, Denmark

Q Would you please identify what has been marked for identification as Exhibit 36-1 (HKJ-1).

A Exhibit 36-1 (HKJ-1) is a résumé of my educational background and employment experience

Q Please summarize and briefly describe your educational background.

A I am a mechanical engineer. I hold an M.Sc in Mechanical Engineering from Aalborg University

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in Denmark and a PhD in Mechanical Engineering Mechanics from Michigan Technological University.

Q Please describe your employer, your position, occupation and profession?

A I work for Vestas Wind Systems A/S in Denmark. Vestas is the largest manufacturer of wind turbines in the world and has been in the business of designing, manufacturing and constructing wind turbines and turnkey wind power projects since 1979. At Vestas, I have held various positions over the last 13 years in Research & Development, product design, manufacturing and overall product management. These positions have included being Project Manager and the Mechanical Design Manager in R&D for 7 years and the Chief Product Engineer for new turbine designs for 6 years. Presently, I am Vice President of Technology. I am a member of the Danish Society of Engineers, which is, in essence, the equivalent of being a Professional Engineer in the United States.

Q What are your primary duties and responsibilities?

A As the Project Manager and Mechanical Design Manager in R&D my responsibilities included design analysis and load and stress calculations for several lines of Vestas turbines. My duties included ensuring compliance of turbine designs with multiple international codes and standards in order to obtain third party design certification for safety and reliability prior to the release of any new turbine design for manufacture and operation.

As Chief Product Engineer at Vestas, I was responsible for defining the design standards for turbines according to commercial market conditions, regulatory requirements and normative

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requirements that set standards and codes for safety. I ensured that the Vestas R&D department integrated these design standards into the development of final manufacturing designs and technical specifications of the turbines. My current position at Vestas is Vice President of Technology, which involves increased management responsibilities and oversight of not only wind turbines, but also of turnkey wind power project construction work.

Q Please summarize and briefly describe your work experience in the wind turbine industry.

A I have worked on the design, testing and manufacture of wind turbines since 1991. I have been the lead engineer on 7 versions of Vestas wind turbines starting with the V39-500kW and then the V42-600kW, V44-600kW, V47-660kW, V66-1.65MW, V80-1.8WW and V90-3MW.

Q Please describe the number of wind turbines that have been installed by Vestas during your tenure with the company and how many wind turbines are in the Vestas fleet.

A In 1991 Vestas had approximately 3,500 turbines in operation, and as of June 2004 we had 26,643 turbines installed worldwide for a total of 15,316 MW. Therefore, during my tenure at Vestas, there have been approximately 20,000 Vestas turbines installed and operated.

Q Please briefly describe the type of work that goes into ensuring a turbine design is safe.

A The first exercise is to determine general turbine blade geometry and design based on aerodynamic performance, manufacturability, material behaviors and overall strength adequacy to withstand the load requirements set forth by a number of standardizing institutions and agencies including the IEC (International Electrotechnical Commission), ISO (International

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Organization for Standardization), DIN (Deutsche (German) Industry Norms), and ANSI (American National Standards Institute) to name a few. Vestas first designs the blades and other components on a computer and analyzes them using a proven aeroelastic modeling software. This software has been used in the design of turbines since 1992 starting with the V42-600kW turbine and has been verified with actual field measurements of turbine loads. These loads are then used in the design of systems and components. We perform critical element analysis and verify that all critical load carrying components of the wind turbine meet the strength and fatigue load endurance requirements set forth by the standards to ensure that they do not fail in the event of loads such as those imposed by peak wind gusts, and fatigue loads beyond the design life of the turbine which is 20 years. All of the calculations and verification testing work are reviewed and scrutinized by a qualified and experienced, independent, third party approval agency such as RISØ of Denmark, Det Norske Veritas (DNV) of Norway or Germanischer Lloyd (GL) of Germany.

Q What is the peak gust survival wind speed for Vestas turbines?

A The peak 3 second gust survival wind speed for IEC Class 1 Vestas turbines is 70 m/s, or 157 mph and for our IEC Class II it is 59 m/s or 132 mph.

Q Please describe the risk of a modern wind turbine losing a full blade or portion of a blade during operation.

A. A modern, well maintained turbine has a probability of less than one in a million (1/1,000,000) of losing a full blade or having part of a blade coming loose or collapsing. The 1/1,000,000 is a standard which is part of the codes used to determine the load cases for the design of the wind

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turbines. The highest potential cause is an over speed condition of a gross enough nature to present sufficient forces to cause blade damage and partial separation. During the design process a full-size blade is built and tested to ultimate strength to ensure that the design and construction methods meet requirements to avoid this potential even under severe conditions.

Q Please describe safeguards and systems in wind turbines that prevent this from occurring.

A Current wind turbine designs utilize multiple, independent and redundant safety systems to prevent over speed situations. Speed control limits are normally monitored and controlled by the main control system. A second, fully independent system called the Vestas Over-speed Guard (VOG) is also constantly active which will automatically halt the turbine in the event of a main controller failure or other critical alarm fault. Each system can halt the turbine completely independent of the other. Each system will prevent the turbine from operating unless they are both operating properly and communicating with each other. On all of our megawatt class turbines, each blade is equipped with an independent pitch system and nitrogen accumulator which is like a compressed air tank. Even if only one blade can be pitched, it will prevent the rotor from being able to enter into an over-speed condition. In the event of power loss or a loss of hydraulic system pressure, the nitrogen accumulators instantly deploy to pitch the blades into the neutral position and halt the rotor. Under a full stop condition, the turbine is able to halt the rotor in less than 3 revolutions. The blades are also designed with a safe-pitch aerodynamic configuration which means that even if all of the braking systems fail that the blades will naturally pitch to a neutral position to prevent rotation. Essentially the blades need to be held in place with the hydraulic system in order to maintain rotation. If that hydraulic pressure is lost, the blades will feather back simply due to their aerodynamic design.

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Q Do you have any knowledge of incidents where the turbines blades have come off?

A Yes. This happened once with a Vestas V39-500kW turbine in Denmark in 1992. The failure analysis determined that the blade to hub fastening system had failed due to a combined manufacturing and design defect. The blade fastening system was immediately redesigned and the manufacturing system was modified to remedy the problem and the entire fleet of V39s was retrofitted.

Q How far did the blade get thrown?

A The blade was thrown approximately 50 to 75 meters.

Q Have there been any blade throw incidents with Vestas turbines since the design modifications?

A No.

Q During your tenure at Vestas, have any of their turbines experienced a tower collapse?

A Yes. In France, a V39 collapsed due to delinquent operational procedures and, in Germany, a prototype V80 machine on a 100 meter tall tower collapsed.

Q Please describe the conditions which affected these tower collapses.

A The V39 turbine in France was without power for more than 3 months and the rotor blades were being held in the neutral position by the hydraulic system. Since the blades were not locked into

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position on this particular machine as they should have been, the blades were released from the neutral position after about 3 months once the hydraulic pressure was slowly released over such a long period. The Vestas operations manual indicates that if the turbine is ever without power for more than 48 hours that the blades need to be locked into the park position. This release combined with a high wind event caused the rotor to start spinning and an over-speed condition occurred which ultimately caused the collapse of the turbine.

The V80 turbine in Germany was a very new machine configuration with the very first 100 meter tall tower which is the tallest tower for a Vestas wind turbine. On this particular machine, the tower flange had a weak weld which broke and caused the tower to collapse. The tower was not manufactured by Vestas, but by a sub-supplier and the quality defect was very rare. Normally all tower welds, especially the tower base flange weld, are inspected by ultrasonic equipment to ensure that the weld has no voids and is fully homogeneous.

Q Have there been any subsequent Vestas turbine tower collapses other than these two?

A No.

Q Please describe the risk of a wind turbine experiencing a full tower collapse.

A Other than the rare occurrence of a tower base flange weld defect, extreme over-speed conditions would be the primary concern which might create the forces needed to cause a tower collapse.

Q Please describe the risk of a wind turbine catching on fire.

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A Turbine fires are extremely rare on modern turbines. This happened on turbines in the 1980s primarily due to disc brake problems which deployed and overheated. Newer Vestas turbines do not have a high speed disc due to the adequacy of the other redundant braking systems. Modern turbines are equipped with additional fire safeguards such as lightning arc detection and specially engineered grounding systems and transformer arc detectors, and all electrical equipment meets or exceeds local and international electrical safety standards set forth by the National Fire Protection Agency (NFPA) and National Electric Code (NEC). Almost all types of modern wind turbines, including Vestas, are also equipped with multiple temperature sensors mounted on parts of the turbine machinery prone to higher temperatures. If the control system detects temperatures outside acceptable limits it will trigger the automatic shutdown of the turbine and send an alarm to the central computer system which will in turn alert on-call service technicians of the fault location, fault code and turbine location. The turbines are designed with a special lightning protection system which includes lightning receptors in the blades which divert lightning strikes through the tower to the base flange and into a special grounding system consisting of copper rods and conductors buried around the foundation of the towers. Special varistors also protect the electrical and control systems of the turbines from stray lightning surges which can cause damage to these components.

Q Please describe the possibility of a wind turbine throwing ice.

A Wind turbines can throw ice from the blades and drop ice from the tower. The ice falls from the blades and tower once a turbine restarts after standing still after a heavy icing condition has existed for a significant period of time. The ice throwing distance is generally small due to the low rotational speed of the turbine during start-up.

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Q Please describe any safeguards that can prevent this from occurring on wind power projects.

A The wind power project's central control system can be programmed to detect icing events using the wind vane and temperature sensors. When the temperature falls below or hovers around freezing (0 degrees C) and the wind vane sticks to one direction, an icing event may be occurring. I understand that the Project will be fitted with multiple wind vane sensors at a number of locations to ensure that there is a redundant system in place for ice detection. If an icing event is detected, the central control system can detect this and perform any necessary action.

Q Please describe the types of fluids inside a wind turbine which might cause a hazard due to a spill.

A Most modern wind turbines, including Vestas machines, utilize lubrication oil, grease and cooling fluids similar to modern automobiles. Vestas wind turbines have been designed to contain all spills inside the nacelle, hub and tower. I have never heard of damage caused by spills from a turbine.

Q Please describe the risk of electrocution to the public from a wind turbine

A The risk of electrocution to the public is insignificant due to fact that all electrical equipment is enclosed in the nacelle and the tower, and shell clad enclosures are designed to IEC codes and NEC (National Electric Code) standards. All towers are secured with heavy steel doors and locks. I have not heard of any damage to persons and property in this regard.

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Q Please describe the risks of electrical and magnetic fields (EMF) to the public from a wind turbine.

A The generator and transformers which are mounted in the nacelle and tower do produce a small amount of EMF which is limited to the immediate enclosure. The type and strength of the EMF is similar to EMF produced by electric distribution transformers, which are found in residential areas all over the world. We are not aware of any instance of individuals or animals being harmed by EMF from similarly sized transformers used in public utility systems, so the likelihood that the EMF generated in a turbine 200 to 300 feet above the ground will harm anyone or anything is minute. All turbines comply with international standards on EMF emission and compatibility.

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